Preface

Introduction

Economic life is governed by expectations. As common sense suggests, economic agents base their decisions upon beliefs that delineate images of the future. However, the theme of expectations has only emerged slowly, in an explicit way, on the scene of economic analysis. Without engaging in a retrospective on the history of economic thought, which is better left to specialists, it is useful to start recalling some key facts about the intellectual history of economic theory in the last century.

Expectations in the Economic Debate in the Twentieth Century: A Brief Reminder

In the 1930s, John Maynard Keynes puts expectations at the forefront of the intellectual debate. He detects the trace of "animal spirits" behind investment decisions reflecting the vision and also the mood of entrepreneurs. The popular postwar version of Keynesianism putting emphasis on the quantitative adjustments behind the famous textbook "multiplier" leaves this dimension of the Cambridge master's message in the shadow. His opponents probably take more seriously the scope of his criticism and, ironically, turn it against him. In the 1950s, the effectiveness of macroeconomic policies of Keynesian inspiration become doubtful. In Chicago, Milton

Friedman claims that economic agents cannot be systematically fooled, so that the view of the inflation-unemployment trade-off underlying keynesian recipes is wrong. Also at Carnegie Mellon, John Muth (1961) argues that agents refer to the "relevant economic theory" so that their forecasts are as good as those of the economists. Robert Lucas later strengthens the thesis while giving it fuller intellectual respectability. Just beneath the surface of the macroeconomic debate, the keywords, credibility and independence, of the western monetary policies of the 1990s emerge.

Following Lucas's advocacy, economic theory's agents have more and more "rational expectations." The scene of the economic intellectual debate of the end of the twentieth century is set. Some fields of theoretical modeling, first, and then economic theory as a whole, fall within the new paradigm. Policy discussion often follows the path, implicitly or explicitly. And politicians, like as Molière's Monsieur Jourdain, without naming the idea, will rely on it.

The "Keynesian" revolution is followed by the "Lucassian" counterrevolution. The alternation is unsurprising and reflects a pendular movement of ideas, the antagonistic poles of which are the trust or, on the contrary, the distrust of markets. Keynes doubts the ability of markets to coordinate agents' expectations: For him the stock exchange is a "casino" and economic life is marked by the "disappointment of reasonable business expectations, one of the greatest evils of our time" (1931, 317). The rational-expectations hypothesis conveys, on the contrary, great confidence in market mechanisms. Naturally, the controversy is not settled in the coddled world of models. The Great Depression gives credence to Keynes's intuitions, much as the collapse of the Soviet system gives legitimacy to the market and attenuates criticism, even criticism regarding the quality of expectations that it generates.

However, *the intellectual debate is not over*. Its empirical face is most visible. Facts are stubborn: For example, it is not obvious, to say the least, to explain actual stock markets' fluctuations using

dynamic models that adopt some (not too loose) version of the rational-expectations hypothesis. Other facts suggest the same challenge, either routine facts, such as short-run fluctuations, capital movements, or exceptional facts, like crises.

The debate also has a theoretical face. Economic theory revisits the foundations of our understanding of the formation of expectations in various contexts. Indeed, this is what this book is about: a theory assessment of the rational-expectations hypothesis.

Assessing Rational Expectations: Two Theoretical Viewpoints

This is the second volume of *Assessing Rational Expectations*. The subtitle of the first was *Sunspot Multiplicity and Economic Fluctuations*; this volume falls under the heading *"Eductive" Stability in Economics*. As the first volume did, this one gathers articles, most of them already published, that I authored or co-authored. Expressing gratitude to my colleagues and friends who bear some responsibility for the content of this book is then my first and most pleasant duty. This volume owes more to George W. Evans, whose name is associated with two of the pieces in this volume (chapters 2 and 12); Gabriel Desgranges who coauthored chapters 8, 9, and 10; Jean-Charles Rochet, the coauthor of chapter 7; Stéphane Gauthier, the coauthor of chapter 13; and Pierre-Yves Geoffard, a coauthor of chapter 9, than their shares suggest. The discussions I had with them helped shape many of the ideas developed in this book. Particularly, the continuous intellectual confrontation of my complementary views with Evans, started in the mid-1980s, has been a constant stimulus to my reflection.

In addition to the reproduced articles, three papers aim at providing short surveys on research areas that overlap with the subjects treated in this book. They have been written with two already quoted contributors, Gabriel Desgranges (chapter 10), Stéphane Gauthier (chapter 13), and also Hector Calvo Pardo (chapter 6).

This preface, I guess, should not repeat the previous one. Indeed, the preface to the first volume started stressing a somewhat obvious fact, that is, the *hegemonic position of the rational-expectations hypothesis (REH) in modern theoretical modeling*. Without repeating the previous argument, it is worth stressing that this privileged position has not entirely changed. The REH is still dominating theoretical modeling in most fields, from monetary theory to finance, macroeconomics, and general equilibrium. However, there are signs of change; for example, the development of behavioral finance illustrates the attractiveness of alternative explanatory schemes, even if the concern is not only, or even primarily, expectations. More generally, the idea that the rationality of expectations is not an ultimate modeling axiom, but an assumption that has to be assessed, possibly case by case, is gaining more and more respectability. Indeed, it may look pretty obvious to new generations more attracted by experiments than by pure theory. This (arguably new) intellectual mood can be sharply contrasted with the situation of the mid-1980s, the time when the research presented here was started. Many people in the profession mainstream then believed that "the rational expectations hypothesis was nothing other than the extension of the Rationality hypothesis to expectations," so that the first hypothesis inherited the professional highly respectable status of the second one. This perception was clearly being reinforced by the rise of the concept of Nash equilibrium toward a central place in game theory, insofar as the Nash hypothesis and the REH are two sides of the same coin.

However, since then, the dominant view has been challenged from two different directions. First was the progressive discovery of the striking questions raised by *multiplicity*, progressively unveiled both by economic and game-theoretical investigations. The second and partly related impetus came from *learning* studies. These learning studies, termed "evolutive" in the following, developed earlier in economic contexts, where they were reviving an

older tradition, and somewhat later in game-theoretical frameworks. They have subjected the validity of Nash and rational-expectations conjectures and predictions to intensive scrutiny. The reevaluation of the performances of these central concepts that they trigerred was initially slight but has proven prolonged and continuous. Both sketched themes are echoed in the title common to the two volumes of the present book, the assessment of rational expectations. Each volume illustrates one of the two routes just evoked.

The first volume was concerned, roughly speaking, with the multiplicity question. *Self-fulfillment* of expectations is compatible with multiple realizations. A suggestive word, "sunspot equilibrium," designates a new concept. Sunspots here are metaphorical, reminiscent of the above-mentioned "animal spirits," let us say "rational animal spirits." What economists refer to as sunspot multiplicity may also feed a theory of endogenous fluctuations. The titles of the parts of the first volume speak for themselves: Sunspot Fluctuations around a Steady State: The Case of Simple Overlapping Generations Models (part I), Fluctuations between Two Steady States in Lucas-Like Models (part II), Endogenous Fluctuations in *N*-Dimensional Models (part III). They echo, in the context of fluctuations models, the multiplicity question.

This second volume, indeed, may be related to learning considerations, although these learning considerations are not standard "evolutive" or "evolutionnary" learning (agents learn the future from the past). Learning, here, relies on a mental inspection of what is going on: Agents have to guess what the others guess and so on and so on. It will be labeled, following the semantic suggestion of Ken Binmore (1987), "eductive" learning.

"'Eductive' Stability of Expectations": The Global Viewpoint

Hence, the general theme of this book is an assesment, from the "eductive" viewpoint, of the rational-expectations hypothesis

in a collection of economic models. In these models, a rational-expectations equilibrium is subjected to an "eductive stability" test. If it passes it, the equilibrium is then said, in the terminology adopted here, to be "eductively stable" or "strongly rational." (The second term was introduced in my early articles [1988, 1992]; the more recent articles, as well as other authors, refer rather to the first term.)[1] The concept of "eductively stable equilibrium" (or "strongly rational") or by extension of "eductively stable expectations" is defined repeatedly within the volume, with the precision required for the application. The inspiration for the concepts used here relies heavily on ideas that have been either developed or at least intensively used in game-theoretical studies. *Iterative dominance* was at least introduced in Luce and Raiffa (1957) and studied by Moulin (1979a,b), before Bernheim (1984) and Pearce (1984) revived and improved the idea, making "rationalizability" popular among economists. *Common knowledge*, introduced by Lewis (1969) and discussed by Aumann (1976), is in the background of rationalizable solutions as understood earlier and made formally clear in Tan and Werlang (1988). "Eductive stability"—or "Strong rationality"—as defined here closely echoes the just-mentioned notions. It makes little sense to provide here a formal definition of the concepts on which the analysis of the book relies, let alone an extended theoretical assessment. Let us rather introduce the spirit of the analysis and the key ideas through the example of a simple game.

Assume that many people,[2] gathered in a room, are asked to write confidentially on a sheet of paper any real number between zero and one hundred. This is a "game," the rules of which are the following. The winner(s) will be the one(s) whose number is closest to two-thirds of the average of all the numbers submitted by all other participants. As a game, this situation has a unique Nash equilibrium: All agents submit zero, and all get (or share) the prize. In an economic context, to which I now choose to refer, this equilibrium would be labeled[3] a rational-expectations equilibrium,

or more exactly, a perfect-foresight equilibrium. Is it "eductively stable"?

The answer is in the affirmative and based on the success of the following set of guesses, second guesses, etc.: First, nobody, here, if he or she understands correctly the situation, will play more than $(2/3)(100) = 66.666$: Whatever my beliefs, I have a response in (0–66.66666) that dominates[4] playing strictly above 66.666. Hence, rational players' responses are in the interval (0–66.666). But assume that each player knows that the others are rational. He or she then knows that nobody is playing above 66.666. Every player then concludes, repeating the dominance argument sketched above, that he or she should not play above $(2/3)(66.666)$. Note the assumption on which this second conclusion is based: "Everybody knows that everybody is rational" is not the same as the assumption justifying the first conclusion ("everybody is rational"). A third and more demanding assumption—"Everybody knows that everybody knows that everybody is rational"—would lead, along the lines of the same reasoning, to the conclusion that nobody plays more than $(2/3)(2/3)(66.666)$. And if I assert, with obvious notation, that $(\text{everybody knows})^N$ that the agents are rational, then the response of everybody will be smaller than $(2/3)^N(66.666) = (2/3)^{N+1}$. The assertion $(\text{everybody knows})^N$ that the agents are rational, whatever N, defines common knowledge of rationality. Hence, as defined, common knowledge of rationality (and of the game) implies that all agents reach the same conclusion: *The equilibrium is guessed or "educed"* though the mental process just described; the equilibrium is the unique "rationalizable solution" or the unique "rationalizable expectations equilibrium." It may be said to be "eductively stable" or "strongly rational": This is the terminology adopted in the book.[5]

The reader has noted that the equilibrium under consideration is the only possible equilibrium in the situation (let us call it the two-thirds situation). But one should not conclude that uniqueness

of the equilibrium implies "eductive stability." To see that the assertion is mistaken, take the same "game" in which two-thirds is replaced by three-halves and allow people to announce any positive real number, rather than restricting the announcement to being between zero and one hundred. This game has the same equilibrium as the previous one, but it is not "eductively stable." Knowing that the others are rational does not help one to choose a number, and so on. "Eductive learning" has no chance to succeed here.

Note, however, that the criterion is powerful, not only when equilibrium is unique, but also when there are several: Take now the three-halves game but assume that, as in the two-thirds game, announcements have to remain between zero and one hundred. There are two equilibria: zero and one hundred; the reader will easily check that the spirit of our stability criterion leads to choosing the second equilibrium (one hundred).

The above story, a collective mental process that leads people to "educe" the equilibrium, provides a presentation of the general inspiration. Coordination on the rational-expectations equilibrium does not rely, as some optimistically thought at some time, on the rationality hypothesis, but on the "common knowledge" of rationality. Eductively stable or strongly rational expectations are, as argued in chapter 1, the unique "rationalizable expectations equilibrium." And the "eductive" process is global in the sense that it does not start close to equilibrium.

"'Eductive' Stability of Expectations": The Local Viewpoint

Naturally, the just stressed "global viewpoint" is very demanding. It has, however, a local version that can be introduced from the previous examples.[6] Take the two versions of our game. In the two-thirds version, announcing zero is locally "eductively" stable in the following sense: A hypothetical initial collective belief that everybody will play a number less than epsilon, epsilon close to zero,

will trigger the convergence of the "eductive learning" process to zero. On the contrary, the same collective belief with three-halves is without power. Even if one believes that everybody will play less than epsilon, one may want to play more than epsilon. In other words, such a belief, even if it were hypothetically shared by everybody, would not be necessarily self-enforcing. Also, anybody knowing that latter fact cannot maintain, if he or she knows that the others know that the others are rational, the hypothesis that everybody's belief regarding the others' actions is less than epsilon. In a sense, *the assertion "It is common knowledge that everybody plays less than epsilon" is self-defeating*. It is worth noting that the "defeat," or meaninglessness, of the latter assertion is checked through a one-step process: There are individual beliefs, compatible with the hypothetical collective belief, that induce people to play above epsilon.

The local content given to the stability criterion, along the lines we have just sketched, makes it less demanding and also, in a sense, less theoretically pure. But changing the perspective of the general methodological inspiration may make it more intuitively binding. *Stability is no longer viewed as trigerred by the convergence of a mental process*, theoretically well grounded but somewhat unrealistic, even in its local version. Rather, although equivalently, it is associated with the fact that *no approximate collective belief about the position of the equilibrium is self-enforcing, whenever agents are rational and know that they are rational, and a fortiori, whenever rationality is common knowledge*.

In other words, the negation of local "eductive stability"—the fact that there is no small neighborhood (here $\varepsilon > 0$) such that the general belief that the outcome is in the neighborhood (here within ε) of its equilibrium value, is self-enforcing, whatever the chosen (nonempty) neighborhood—signals, from a simple one-step argument, a coordination fragility of the equilibrium under consideration. The risk of instability of expectational coordination, in such a situation, relies on a compelling theoretical assessment, the failure

to make sense of the assertion "It is common knowledge (CK) that rational agents will play in a neighborhood of the equilibrium," and has a neat and immediate intuitive content.

In a sense, the program of this volume is to test the plausibility of expectational coordination, along the lines just sketched, for a (hopefully not too small) class of economic models. If global "eductive stability" only were concerned, the program, described in a caricatural way, would aim at classifying models, as a function of the underlying parameters, in either the same category as the first game (two-thirds) or the (first version of the) second one (three-halves). In fact, as the analysis takes the "local" viewpoint, it leads, viewed somewhat caricaturally again, not to separate models, but to separate equilibria under consideration in two classes: those that are locally similar to the (unique) equilibrium of the two-thirds game (the "eductively stable" or "strongly rational" ones) and those that are locally similar to the (unique) equilibrium of the (first) three-halves game.

This discussion may suggest that "eductive stability," in fact "local" eductive stability, is a refinement device for rational-expectations equilibria: It selects "eductively stable" equilibria where expectational coordination is plausible and rejects non-eductively-stable, and then nonplausible, ones.[7] Refinement may, however, be a misleading terminology.[8] It should be clear that the criterion used here does not necessarily "refine": It may just as likely lead to rejection of all equilibria, even if only local stability is concerned (as is already the case for the three-halves game above).

"Eductive Stability" in Perspective

Let us first briefly clarify, although this will be done again and in a more pedestrian way through the articles of the volume, the connections between the work presented here and the work undertaken elsewhere, first in game theory, then in economics.

First, and obviously, learning has arrived on the agenda of game theorists, and more forcefully in the 1990s. It had already long been on the agenda of economists, and in a sense, it is a subject common to both fields, in which work is hopefully complementary.

Second, the recognition of the game-theoretical flavor of the "eductive stability" criteria developed here does *not* make this book *a chapter in game theory*. The work presented here is concerned with economics; it discusses not the prisoner dilemna or the battle of the sexes or the centipede games, but partial equilibrium à la Muth, inventories and speculation models, macroeconomic models à la Keynes-Walras, saddle path solutions, and transmission of information through prices. In some contexts, as in so-called models with strategic complementarities, a parallel exploration of the issues by economists and game theorists unveiled hidden common structures, and hence, the analysis could benefit from some general theorems. This is not the case here, where the detailed analysis of a variety of problems reveals different formal structures. These structures do reflect the different economic contexts under scrutiny: The more general inspection that they may call for is presently not available. More basically, the ultimate objective of the analysis is to deliver economic messages. Constructing building blocks of economic intuition on the conditions for successes or failures in expectational coordination is a present challenge. It is faced in this book.

What are the connections between this "eductive stability" research program and other research programs in economics? The connections with what comes under the heading "learning" are discussed at length through the chapters. In particular, the "eductive" and the "evolutive" learning viewpoint are compared within each chapter in the context of each specific model under scrutiny. However, a careful comparison of the results obtained in this book and those of different strands of literature, learning in games (Fudenberg and Kreps [1993], Fudenberg and Levine [1998]), and "evolutionary learning" (Weibull [1995]) would require a more

specific attention. The concept of iterative expectational stability (IE-stability), proposed at the beginnig of the 1980s, and the more widely used concept of differential expectational stability, which aim, to some extent, to provide an "eductive" view of "evolutive" studies, are discussed. In particular, as shown in chapter 2, (co-authored with Evans), the connections between iterative E-stability and "eductive stability," as considered here, are scrutinized. The "eductive viewpoint" adopted here has companions in the economic literature that are referred to within the book. Dominant-solvability arguments are systematically used in a subset of the literature that follows more or less Carlsson and Van Damme (1989, 1993). For example, the Carlsson and Van Damme *contagion argument* has been used to explain financial crisis, although in models that put emphasis more on uniqueness than on iterated dominance (Morris and Shin 1998). This branch of the literature exploits ideas rather different from the ones exposed in this book: It relies heavily on the fact that "intrinsic" uncertainty, as a result of some kind of noisy transmission to the agents, is not common knowledge. The noise in intrinsic uncertainty helps, exactly in the same way as structural uncertainty does in the work of Carlsson and Van Damme, in eliminating strategic uncertainty. The results rely, however, on special hypothesis, concerning the connection of information between agents, the binary nature of decisions. More basically, the powerful deus ex machina that some form of incomplete information provides,[9] does not operate outside a limited class of models with strategic complementarities and may even have elsewhere an adverse effect on coordination (Guesnerie [2004]).

The question remains of the connections between the "eductive viewpoint" on expectational coordination and the mutiplicity approach. In a sense, arguing about uniqueness as a sufficient condition for successful coordination, or more generally about multiplicity, is an "eductive" approach. Also, as constantly argued elsewhere (see chapter 10 in the first volume), there are close con-

nections between the different viewpoints on expectational coordination, including the viewpoint of "eductive stability," and the multiplicity one. Going further in that direction would help build a bridge between the first and the second volume: A contribution to this task is provided in chapter 13. Finally, the analysis of the connections between the content of this volume and the objectives and findings of the literature presented in Chamley (2003) would deserve specific scrutiny. Such an analysis is not conducted here, although some comments appear in chapter 3.

The question of the *empirical support* of the theoretical analysis sketched here has finally to be raised. Again, it will not be treated in depth in this book, for two reasons. The first is that the theory probably still remains short of its objective, that is, providing a comprehensive catalog of the qualitative factors that affect expectational coordination. The second is that the empirical implications of the theoretical analysis of expectations undertaken here are not fully elucidated. The theory suggests that rational-expectations coordination is more likely when some well-chosen criteria are met but does not make any prediction when they are not. The conceptual and statistical questions of the appropriate tests of the theory, and especially of the appropriate appraisal of its instability predictions, remain open.

The theory can also be subjected to *experiments*. And to some extent, such experiments have been started. For example, while teaching courses in the mid-1980s and early 1990s, I used to play the two-thirds game with my students. These experiments did not meet the professional criteria of the experimental field but have initiated such professional work.[10] Although Nagel's (1995) results deserve comments more sophisticated than the present ones, I believe that they confirm, in regard to one essential point, the amateur experiments I had undertaken. In the two-thirds game, zero is a good predictor of actual play in the following sense: The actual winner does not play zero but generally something between ten

and twenty, and if the game is repeated, the winner's number becomes closer and closer to zero. This may be viewed as a first satisfactory point and a piece of support for the theory, particularly if one notes that the winner of the (first) three-halves game normally quotes a high number that explodes through repetition. Whether the predictions of some of the models presented here pass the experiment test is an open question on which work is ongoing (Sutan and Willinger 2003).

Content of the Book

This volume is divided into five parts: The first part is entitled "Eductive Stability: Introductory Analysis and Overview." The second part deals with "General Equilibrium Expectations: From Macroeconomics to Microeconomics." The third part is devoted to "Coordination in Finance Models." The fourth part focuses on "Intertemporal Eductive Stability." The fifth part concludes.

Eductive Stability: Introductory Analysis and Overview

Chapter 1, "An Exploration of the Eductive Justifications of the Rational-Expectations Hypothesis," was first published in 1992. It rearranges and extends the argument first developed in Guesnerie (1988, 1989). It focuses attention on a version of Muth's pioneering "agricultural" model: "farmers" have to decide on the size of their crops, and for that they have to predict the (possibly random) price that will ultimately prevail. The chapter presents the concepts and methods of the analysis of "eductive stability" or "strong rationality." It introduces key insights that will recur later in the volume and stresses basic intuitions about the stabilizing role of higher demand elasticity and, on the contrary, the destabilizing role of higher supply elasticity. The chapter also extends the initial analysis in several directions: multidimensional predictions, sequentiality of

decisions, and so on. The corresponding themes are scrutinized further in chapter 3 in particular.

Chapter 2, "Rationalizability, Strong Rationality, and Expectational Stability," compares the "eductive stability" or "strong rationality" concepts used in the previous chapter with the already introduced concept of iterative expectational stability. In contrast to the former concepts, which are associated with the uniqueness of rationalizable expectations when initial beliefs are restricted, the latter has no game-theoretical foundations. We compare the concepts within an n-dimensional, two-period, one-step-forward-looking model. For that, we embed the standard expectational model in a game-theoretical framework. It is shown that, in this setting, the two concepts coincide when agents are homogenous. The chapter shows that when agents are heterogeneous, iterative expectational stability is a necessary condition of eductive stability. A more demanding sufficient condition for the latter is also provided. Curiously enough, the game theoretically oriented view of expectational stability developed here provides some support for a concept, IE-stability, that has been more or less abandoned, in part because its lack[11] of game-theoretical foundations! Also, the fact that some kind of IE-stability is a necessary condition for "eductive stability" is, as will be seen later and in particular in part IV, a very general property.

Chapter 3, "Anchoring Economic Predictions in Common Knowledge," published in 2002, relies on the 1996 Econometric Society presidential address. The first part of the chapter provides a synthesis of what has been achieved in chapters 1 and 2, while putting the results in a broader perspective. For example, it generalizes some of the findings concerning either the connections between evolutive and eductive learning or the effect of the timing of decisions on expectational stability. It also attempts to express intuition on the factors governing expectational coordination, while discussing the robustness of the insights. The second part of the chapter

provides an introductory overview of some of the themes that are not covered in this volume or of some others that are investigated later in the finance (part III) or dynamics (part IV) segments of the volume, to which it provides an introduction.

General Equilibrium Economics: From Macroeconomics to Microeconomics

The Muth model is conceptually a partial equilibrium model, indeed, it is the prototype of partial equilibrium models. Technically, it displays, in the now-fashionable terminology, strategic substitutabilities: the fact that other farmers are expected to increase their production induces a given farmer to decrease his own production. The conceptual switch from partial to general equilibrium, in this second part of the book, is accompanied by a technical switch of emphasis from strategic substitutabilities to strategic complementarities. The fact that general-equilibrium-like income effects generate strategic complementarities has been stressed more or less recently in several contexts (e.g., search models, noncompetitive general equilibrium). In a sense, it is an old idea: Strategic complementarities associated with general equilibrium income generation echo, in a modern mood, Say's assertion according to which "supply creates its own demand." The purpose of the book's second part is to explore to what extent such general equilibrium strategic complementarities interfere with the earlier partial equilibrium considerations in the formation of stable expectations. This is the subject of chapters 4 and 5, which consider production economies. The issue is no longer central in the last contribution of the part, chapter 6, devoted to a preliminary investigation of "eductive stability" in exchange economies.

Chapter 4, from 2001, is entitled "Short-Run Expectational Coordination: Fixed versus Flexible Wages." It provides an introduction to a more general program of understanding expectational coordi-

nation in macroeconomic contexts. Indeed, this chapter explores a simple three-good model that had previously been used as a reference for discussing macroeconomic issues. Although the model is no longer fashionable, the key ideas that its analysis captures are likely to survive in most macroeconomic general equilibrium contexts. Indeed, the main stylized conditions of macroeconomic expectational coordination are present: Consumers that have to decide between present consumption and postponed consumption (savings, here through money); a large number of firms, supposedly in a competitive environment, that have to make production decisions for tomorrow; and simplified market institutions (flexible price market clearing for goods, fixed wages or flexible wages for labor). The analysis shows how the understanding of expectational coordination drawn from partial equilibrium models à la Muth has to be reassessed in the new context, in which incomes, instead of being exogenous, come from production. Indeed, the sufficient conditions derived for eductive stability reflect how strategic substitutabilities are alleviated by strategic complementarities with Keynesian flavor. These conditions all refer to *the Keynesian "multiplier,"* whatever the context (neo-Keynesian, with fixed prices, *or Walrasian*, with flexible wages). The relative merits, in terms of expectational stabilty, of fixed wages and of flexible wages can be assessed. A more comprehensive discussion of this issue is provided in the chapter. Let us simply say here that predicting the flexible wage that will occur is a source of instability that is more than counterbalanced by the insurance that full employment will prevail in the case of flexibility.

Chapter 4's analysis however raises one question: Are the strategic complementarities captured in the stylized model of the previous chapter by Keynesian-like multipliers an artifact of aggregation—the one (final) commodity assumption? With several sectors, optimism or pessimism in making production decisions is a multidimensional object so that the coordinating forces on beliefs

created by the income effect just emphasized are likely to be weaker. The examination of this question is the subject of the chapter 5, "On the Robustness of the Analysis of Expectational Coordination: From 3 to $n + 2$ goods," previously published in a volume in honor of Werner Hildenbrand. The model is a multicommodity version of the model presented in the previous chapter. Only the fixed-wage version is fully analyzed. The conclusions are mixed: Income effects do indeed have a weakened (but not vanishing) role in coordination. Both the strength and the complexities of the interactions are clarified. The analysis suggests, however, that the standard emphasis on strategic complementarities may often grossly overestimate their role compared to what a truly disaggregated general equilibrium analysis would.

The last of this part, chapter 6, entitled "Eductive Stability in Exchange Economies: An Introduction," establishes the formal conditions for "eductive stability," on the one hand, and iterative expectational stability, on the other hand, in a two-period sequential economy in which, in period 1, spot markets coexist with a financial market. Intuitive findings, rather than formal results, are stressed from the formulas.

Coordination in Finance Models

Finance models describe situations the explanation of which crucially relies on the understanding of the formation of expectations. The chapters in this part of the book refer to two issues in finance: the effects of speculation on expectational stability (chapter 7) and the expectational analysis of the transmission of information through prices (chapters 8, 9, and 10).

In chapter 7, "(De)stabilizing Speculation on Futures Markets: An Alternative Viewpoint," originally published in 1993, a new understanding of possible destabilizing effects of futures markets is offered. The standard model under consideration is given an agricultural interpretation. Eductive stability is analyzed, first in a situ-

ation that allows for storage but in which futures markets do not exist, and then in the same context after the opening of futures markets. Although the equilibrium price is less volatile after the futures markets are open (which is commonly viewed as a stabilization effect), the likelihood of occurrence of a rational-expectations equilibrium, as evaluated from our eductive viewpoint, decreases: Agents find it more difficult to coordinate their expectations.

Chapters 8 and 9 focus attention on the transmission of information through prices. Both consider a simple model with asymmetric information: There are informed and noninformed agents, which are inventory holders or traders. These agents submit demand curves to an auctioneer. Again, the analysis examines whether the agents can plausibly coordinate on this equilibrium through "eductive" reasoning, referring to common knowledge.

In chapter 8, "Common Knowledge and the Information Revealed through Prices: Some Conjectures," there is no "intrinsic" uncertainty due to noise traders. It is shown that the existing fully revealing equilibrium can be educed, either through a quick mental process, when there are enough informed agents, or within a longer process, when there are many uninformed agents. The analysis stresses the differences between "sharp" and "diffuse" information.

Chapter 9, "Do Prices Transmit Rationally Expected Information?" considers a similar model but with noise traders. It is shown that, under reasonable assumptions, the model has a unique partially revealing equilibrium. Its eductive stability is scrutinized. The analysis stresses the role of two effects, "sensitivity" and "amplification," whose product should be small enough. The stability property obtains whenever the equilibrium excess demand is steep enough, that is, when the search for information does not distort demand too much. Neither the influence of the number of informed agents nor that of "noise trading" is monotonic. Real-time learning has strikingly different features.

Chapter 10, "Eductively Stable Transmission of Information through Prices: A Brief Review of Results" provides a brief

overview that puts emphasis on a comparison of the lessons of chapter 9 with other existing results on the subject. It stresses, in complementary ways, that the market, in order to lead to "eductively stable" outcomes, should not transmit too much information.

Intertemporal Eductive Stability

The temporal structure of most of the models under scrutiny in the first ten chapters of the book is extremely simple: People have to predict what others do or will do, most often in a two-period setting in which explaining people's actions amounts to predicting their predictions for the next period. The last part of the book switches the emphasis to the more sophisticated dynamic setting of an infinite-horizon model: Decisions today depend on expectations concerning tomorrow, where realizations themselves depend on expectations on the day after tomorrow, and so on.

The first chapter of part IV, chapter 11, entitled "Successes and Failures in Coordinating Expectations," was first published in 1993: It reproduces the Alfred Marshall lecture that I was invited to deliver at the 1992 meeting of the European Economic Association in Maastricht. The text provides an overview of different theoretical approaches to expectational coordination. Although it would have to be rewritten now in a somewhat different way to incorporate ten additional years of research on the subject, it has the merit of relating the alternative categories of learning, "evolutive" and "eductive," and the central concepts to which the study of expectational coordination has brought attention in the context of dynamical models: indeterminacy and sunspot equilibrium. For that reason, the chapter is a bridge between this volume and the first volume. It also provides preliminary insights on the content of chapters 12 and 13.

As far as dynamical models are concerned, attention in chapter 11 is focused, as was often the case in volume 1, on the standard prototype one-step-forward-looking overlapping-generations model.

Chapter 12, "Coordination on Saddle-Path Solutions: The Eductive Viewpoint—Linear Univariate Models," switches the attention to the one-dimensional one-step-forward-looking model with memory one.[12] Standard economic analysis puts emphasis on the so-called saddle path solution as the reference rational-expectations or perfect foresight outcome. To what extent and in what sense does the general theory of "eductive stability" developed here confront the hegemonic practice of the profession? The answer leads to the distinguishing cases in which indeed "eductive stability," based on reasonable initial common beliefs, unambiguously supports the saddle path selection. Some form of agents' heterogeneity, however, subjects the "eductive stability" of the saddle path solution to additional, problem-specific requirements. In particular, the role of the exact timing of decisions is ascertained.

Finally, chapter 13, entitled "Comparing Expectational Stability Criteria in Dynamic Models: A Preparatory Overview," reappraises some of the general questions raised in chapter 11 concerning the connections among different viewpoints on expectational coordination that coexist in the literature: uniqueness, absence of sunspot, and evolutive and eductive learning. Using the insights of chapter 12, as well as those of other existing literature, it examines the generality of the "equivalence principle" claimed in chapter 11 within a broader range of models: one-step-forward-looking one-dimensional models with finite length of memory, one-step-forward-looking multidimensional models with memory one, and so on.

The volume's final chapter, "The Government and Market Expectations," from 2001, provides cautious concluding remarks on the policy implications of the theory developed in the volume. Indeed, even such cautious conclusions may be premature in the present state of theoretical knowledge and in the absence of empirical studies along the lines suggested here. But the chapter nevertheless provides a concluding challenge.

Brief Afterthoughts

The analysis presented throughout the book covers a rather broad variety of economic situations that may be called *canonical*. Indeed, the partial equilibrium model under scrutiny, the general equilibrium models analyzed, the intertemporal models, and even the finance models describe situations that deserve the label *canonical*. The capital of existing knowledge of the profession on the issue of expectational coordination is very different according to the models under consideration: It is almost nonexistent, at least in general equilibrium settings; it relies on a stock of "evolutive" studies both in partial equilibrium and in the finance models of transmission of information through prices; it has a longer tradition and more entries in the case of dynamic models. It is remarkable that the present methodology allows a *unified approach* to all these problems. In some cases, it confronts old findings, but it often leads to entireley novel insights. It is also worth noting that in a field in which economists have developed more advanced autonomous reflection on expectational stability, that is, the field of dynamic models, the present analysis, although echoing some of the previous findings, also shows their limitations: implicit assumptions on the timing of decisions, ignorance of the heterogeneity of expectations, and so on. Hopefully, the reader will be convinced that we now have sharp and maneuverable tools for thinking about expectational coordination, both in a unified way and through all fields of economics.